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CLINICAL ASPECTS OF AGING CONNECTIVE TISSUES*

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THE connective tissues of the human body take part in the structure and function of all its separate organs and locomotor mechanisms. Notwithstanding this obvious fact, remarkably little attention has been paid to connective tissue as an organic system beyond the pages of descriptive anatomy and the chemistry of its ubiquitous component, collagen. This has been quite unfortunate, since in many areas it plays a conspicuous part in the nature of deformity and dysfunction following the protracted disability of prolonged disease or the acute disability of trauma.

Amid all the attention paid to the contraction of muscles in postpathologic states, their intricate relationship to perimuscular and intramuscular fascia rarely if ever has received the notice it merits. A convincing thesis might be written reviewing the musculoskeletal deformities generally ascribed to "muscle-contraction" and discovering the common misnomer. Only in recent years, for example, has the effect of contraction of the iliotibial band on pelvic and spinal deformity, or the adherence of infraquadriceps fascia to the periosteum of the femur, been properly appreciated. In many such instances it will be found that

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the muscle itself is quite extensible, and the restraining factor to be rather the resistances or adhesions of associated connective tissues.

In considering the effect of traumatic lesions of the locomotor apparatus in the elderly, the influence of certain factors inherent in aging connective tissue is especially pertinent[1]. The ease with which their limbs stiffen and the commonly experienced difficulty of regaining an adequate range of motion after any severe trauma, in spite of the generality of an atrophic musculature, make it desirable to know more about the natural course of aging in the involved connective tissue elements.

In previous essays, the well known age changes in the musculoskeletal apparatus have been discussed[2, 3]. However, during the preparation of the relevant material it became apparent that little of significance had been published regarding concurrent changes in human connective tissue in persons of advancing years. Some work has been done on the elastin fibers of blood vessels[4, 5], and other studies have been directed at the connective tissue fibers of the skin[6]. The latter are of chief interest to dermatology and perhaps to the problems of plastic surgery. There are a number of reports easily available describing age changes in the chemistry of collagen[7-9]. As yet, however, these chemical studies have offered little of clinical significance. Studies on pure connective tissue in the aged have been conspicuously absent.

In order to understand the difference in the functional capacity of the connective tissue system at different ages, it is first necessary to study the structural changes found in aging persons. Observations on gross material have proved quite unrewarding. When human connective tissues of the locomotor apparatus of the elderly are examined at the operating table, the individual fasciae, bands and capsules appear no different to sight or palpation than comparable examples in the younger adult. They are as firm, as glistening and apparently as unworn in a healthy person of 80 years as in one of 20. It would be of considerable importance to be able to test their resiliency *in situ* by physical means, but this would necessitate some degree of detachment from their tissue beds and thereby introduce distorting variables of immeasurable degree.

Therefore the first study in this project was aimed at the structural histology of the musculoskeletal connective tissues. In order that observations be kept comparable, sections were examined from a similar structure of each individual. A strip of human fascia lata was taken from

a group of patients ranging in age from 13 to 89 years, who were undergoing surgical intervention for lesions not directly involving this tissue. Sections of each of these specimens were treated with several special stains and were studied as parallel series. It was observed that the musculoskeletal or pure connective tissues are remarkably stable and that little change ordinarily occurs until quite an advanced age is attained. However, the change which then occurs proved to be of very considerable interest to the clinical problem of rehabilitation of the elderly. These data have been separately recorded[10].

To summarize the findings, it was noted that there were no perceptible changes in the cytology of the specimens nor was any significant variation observed in sections stained for collagen by the usual van Giesen method. This latter was to be expected and may or may not be significant, since there is no satisfactory stain for demonstrating the structural aspects of collagen fibers. An attempt to search for changes in the mucopolysaccharide content of aging fibers, by employing the Schiff stain for periodic acid, was equally unproductive. The only specific change noted in the sections of the older age group was found in the elastic fibers, marked for the purpose by the Verhoef stain. These showed a strong though variable tendency toward coarsening and fragmentation.

This manifestation of the aging process, as is true of structural changes occurring in all parts of the body with advancing years, is never uniform. It is variable in each specimen, being prominent in certain fields and absent in others. Just as white hair, cartilage degeneration or vascular sclerosis appears gradually and unevenly, so also does the degeneration of elastic fibers in the musculoskeletal connective tissues. But in all specimens of the aged group, compared with those of adults under 60 years, the changes are definite and usually appear to increase with advancing years.

The structural changes having been observed, their application to certain clinical problems of the aged becomes obvious. Any traumatic lesion of the locomotor apparatus must of necessity involve, directly or indirectly, some part of the connective tissue system. The end-result of the treatment of a fractured hip, even when union has been successfully obtained, owes at least part of its speed of functional recovery to the relative elasticity of the joint capsule, the juxta-articular ligaments and fascia lata. Fracture of the lower third of the femur inevitably involves

its anterior periosteum and overlying subquadriceps fascia. If these two connective tissue planes become adherent or involved in the reparative callus, the extent of subsequent knee function will depend to some degree on the elasticity of their uninvolved portions. Similar examples may be drawn from all fractures of the long bones, and the most persuasive instances are those associated with fractures at or in the vicinity of the articulating surfaces of these long bones.

It has been repeatedly noted that while uncomplicated compression fractures of the vertebrae ordinarily cause no great disability, the response of the spinous and paraspinous ligaments to such injury in the aged often conditions the nature of the postfracture subjective complaints[3]. Persistent strain of the less elastic dorsolumbar or lumbosacral ligaments and fascia are almost characteristic of vertebral fractures in the elderly, frequently at levels other than that of the fracture itself. It is common knowledge that healed fractures about the shoulder take far longer to regain an acceptable range of motion in the aged than they do in younger adults, and conversely, it is not an uncommon experience to find that mechanical measures designed to hasten such recovery in the younger group may even retard it in the older.

Following muscular trauma in the aged, for example, a severe contusion about the anterior tibial or calf muscles, so-called "muscle stiffness", is often unduly prolonged. Similarly, simple ankle sprains, tendon sheath inflammations, self-reduced traumatic subluxations of the fingers and such traumata elsewhere in the locomotor apparatus, ordinarily require a considerably longer recovery period in the aged than do similar lesions in the younger age groups.

Retardation in functional recovery following fractures or injuries to the soft tissues of the locomotor apparatus is seen to occur in spite of the fact that within the boundaries of clinical perception, in an otherwise healthy elderly person, broken bones unite as rapidly as in younger adults[11], and wounds heal as quickly[1, 12]. It therefore becomes necessary to assign the fault to other factors.

It would be absurd to offer any one item as a simple common denominator for the retardation of functional recovery of the locomotor apparatus in the aged. Vascular, neural, endocrine, metabolic and especially emotional factors all play a part. The present writer has attempted only to add one more rather neglected element to the list. The gradually decreasing elasticity of the connective tissues of the musculo-

skeletal system also adversely influences functional recovery of the locomotor apparatus from trauma or from prolonged disabling illness from any cause. Unlike several of the other retarding factors mentioned, however, this last may be gainfully influenced by the proper conduct of rehabilitation procedures. Like the others, it may also be adversely affected.

It has been generally believed for some time that, while collagen and collagen fibers reproduce themselves throughout the life of the organism, elastin fibers, when once destroyed, do not[10, 13]. This, of course, is the basis of the relative inelasticity of scar tissue. The convertibility of collagen into elastin has been suggested, but evidence has not been quite conclusive. In fact, the origin and development of elastin fibers is one of the least known of tissue phenomena. Although chemical observations may be suggestive, certainly structural studies of sections of pure connective tissues of the various age groups revealed no evidence of newly formed fibers or renewal of existent ones which had broken down.

Whether the degeneration or destruction of elastin fibers visible in aged connective tissue is entirely the effect of the time factor of age, that is, a manifestation of tissue catabolism, or whether it is merely the result of decades of wear and tear of unremitting mechanical activity on an elastic structure, is as yet, of course, a matter for speculation or of unwarranted deduction. In the present state of knowledge concerning these apparently acellular fibers, no valid answer to the question is possible. It is a fact that the same effects are seen as often in elderly women as in men of comparable age, and it should be borne in mind that in an urban community, such as that from which the specimens were obtained, women ordinarily do not undertake as heavy physical tasks as their menfolk. These factors would imply that the more or less equal changes seen in their respective elastin fibers are not altogether governed by mechanical stresses. However, this aspect of the subject may be left for future study.

The clinical significance of the relative loss of elastic fibers in the connective tissues of the aged, whether catabolic or mechanical, is obvious. It is quite impossible to damage any part of the musculoskeletal apparatus without traumatizing, to greater or lesser extent, the local connective tissues. At times, in addition to the direct local trauma, more distantly connected elements of the system are involved, as in certain injuries to the vertebral column mentioned previously. In the repair of

these connective tissue areas there occurs a degree of reparative fibrosis, the new fibrous components of which are chiefly, if not entirely, collagen fibers, at the expense of elastic elements. And this occurs in the aged at a time of life when the normal elasticity of the tissue is already decreased by natural causes.

Since the primary object of the present writer's interest in the aging connective tissues was its relationship to post-traumatic recovery of the several parts of the locomotor apparatus, these observations seem to bear rather directly on the management of such states. It has been a matter of experience, for example, that the currently fashionable method of rehabilitation by so-called resistance exercises has, in practice, appeared to be more or less futile in elderly people, and, when practiced in accordance with the techniques and powers customarily described in books and papers dealing with the subject, appears to be a retarding rather than accelerating factor. Since in the elderly one is dealing with a demonstrably less resilient tissue than is present in those age groups within which the method was developed, forcing or urging post-disability restoration of function by the added strain of weights is apt to place undue strains on relatively inelastic periarticular and perimuscular parts. In doing so, one may initiate a vicious cycle of strain-pain-protective spasm which may well result in a state contrary to that for which the method has been prescribed. In actual practice among the elderly this phenomenon is particularly apparent in the shoulder and knee regions. Whether the method employed involves the use of so-called "resistance exercises", or whether the same principle is used in the form of calisthenics in which the body or limb itself is the weighted element, both appear to be equally futile in rehabilitation of the aged. "Light exercise", in the sense of formally designed motions, is a euphemism when used in connection with the aged and is almost invariably ineffective.

This does not mean at all that activity of the affected parts is not to be encouraged in the aged. But it does mean that a natural desire to speed up the recovery of function of an injured part must not lead to over-enthusiastic measures which may prolong, if not reactivate, the strains of a local connective tissue mechanism. It also means that in the management of such trauma in the aged, the natural differences inherent in the connective tissue of the musculoskeletal system must be kept in mind when the choice of method is considered. If ever there was a

medical application for the venerable cliché of "making haste slowly", it may well be the recovery of locomotor function in the post-traumatic locomotor apparatus of the elderly.

In place of the formal exercise for the restoration of function in the post-traumatic locomotor apparatus of the aged person, the encouraged daily increase of purposeful activity has usually produced a more rapid recovery with less discomfort and certainly with more cooperation on the part of the patient. It must be recognized that in an elderly individual, especially after fractures involving the joints or juxta-articular areas such as the common Colles' fracture at the wrist, or malleolar fractures at the ankle, a certain degree of permanent restriction of range of motion is often inevitable. Attempts to overcome this by passive stretching or forced active motion may only reactivate the local inflammatory reaction to strain. The constant encouragement of purposeful activity of a kind customary or congenial to the patient will usually carry recovery to an optimum if not maximum degree of usefulness[14]. Attempts to strive for more often defeat their purpose.

In the aged person, the attainment of an adequate range of painless motion is far preferable to perseverance in attempts to strive for a structurally unobtainable or painful maximum. In the absence of any mechanical block due to skeletal deformity, the lessened resiliency and contractions of the pure connective tissues of the musculoskeletal system are apt to be the principal restraining factors.

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